Gender Differences in Pro-Environmental Behaviors and Carbon Footprint Feedback Response

Research Thesis

Presented in Partial Fulfillment of the Requirements for Graduation

with Research Distinction in the Undergraduate School of Environment & Natural Resources

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October 2019

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Abstract

Feedback on individual consumption is a common tool used to influence recurring pro-environmental behaviors (PEBs; e.g., recycling, conserving water, and reducing energy consumption) and is an important component of climate change mitigation. One important aspect that can influence feedback's efficacy in promoting PEB change among a given target audience is the way in which feedback messages are framed. Understanding how demographic variables, such as gender, influence response to feedback can inform more tailored – and perhaps more effective— feedback strategies. The goals of this project are to examine gender differences in baseline PEB and specific types of PEB and to understand how genders may respond differently in terms of cognitions, emotions, and behavior, to feedback framed positively, negatively, or neutrally. This study uses data from a sample of 393 U.S. adults who participated in an experiment in which they were randomly assigned to receive a positive, negative, or neutral feedback message after taking a carbon footprint quiz. Participants' environmental behaviors were assessed before and after receiving the feedback. Overall, we found that females engaged in PEB significantly more frequently than males before and after all feedback messages, contradicting previous findings that women perform poorly relative to men after receiving negative feedback. Examining individual behaviors, before and after feedback, gender differences were found for females eating meat less frequently, conserving water, and using reusable bags and bottles. Females were also found to show engagement in PEB significantly more after receiving emotionally charged positive and negative feedback, while the opposite effect was observed for males, who engaged in the most PEB after receiving the neutral feedback valence. This research reveals gender as a determinant of PEB and response to carbon footprint feedback. These findings are important to climate mitigation and promoting higher PEB in society by informing more effective feedback intervention strategies that will likely continue to proliferate.

Keywords: Gender, Feedback Valence, Pro-Environmental Behavior.

Introduction

In order to hold global warming to 1.5 degrees Celsius, scientists project that carbon neutrality must be achieved by 2045, requiring significant emissions reductions today Wiedenhofer, Smetschka, Akenji, Jalas, & Haberl, 2018). Emissions analyses have shown that 65% of fossil fuel and cement production can be attributed to household consumption, and 75% of household footprints are a result of direct and indirect emissions from housing, mobility, leisure, diet, and consumption choice (Wiedenhofer et al., 2018). Therefore, transformation of everyday individual behaviors is an essential component of climate mitigation, and can be addressed through increasing emissions reduction behaviors known as 'pro-environmental

behaviors' or PEBs. One method that social scientists can use to improve PEB engagement among individuals is feedback intervention, or the act of providing knowledge of the results of a behavior or performance to an individual, in order to influence future performance (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Schultz, 2014). For example, giving someone feedback about their current energy usage relative to others in order to promote reduced energy usage is one example of a feedback intervention strategy in the context of PEB. Feedback on consumption has been proven to be an effective tool for promoting PEB, and tailoring interventions to individual audiences can make feedback messages more effective at translating to behavior change (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Schultz, 2014). From a social science perspective, understanding how demographic factors, such as gender, are related to differences in environmental attitudes, behavior change, and the psychological processes preceding environmental behavior change can help inform theory, policy, and appropriate strategies, such as feedback intervention, that influence PEB.

Before examining gender as a variable and potential determinant of environmental behavior, it is important to explicitly recognize that there are diverse gender identities and expressions that fall outside the categories of 'man' or 'woman'.' There is very limited research on individuals who identify as non-binary, although it is estimated that non-binary individuals make up 25-35% or more of transgender populations (James, Herman, Rankin et el. 2016). A 2017 poll found that 12% of millennials identify as transgender or gender non-conforming, and a survey of 1000 U.S. adults ages 18-34 found that the majority recognized gender as a spectrum rather than a man/woman binary (GLAAD & Harris, 2017, Benenson Strategy Group, 2015). Although this study is limited by sample size, examining gender as a variable and potential determinant of PEBs can shed some light on which dimensions of society are currently engaged in PEB and which are not. For example, it is well-documented that women eat less meat than men, giving researchers justification to determine effective intervention and communication strategies for encouraging plant-based diets among men, and continue to support women's efforts by increasing messaging strategies that have historically been persuasive to women (Greene-Finestone et al. 2005; Raty, Carlsson-Kanyama 2009). This study examines 14 individual PEBs to shed light on whether there are gender differences among a breadth of specific household and public behaviors. Overall, knowledge on who is and is not engaging in PEB, in addition to what message frames are effective at promoting PEB engagement for different demographics, can help researchers determine where improved intervention strategies are needed, and which types are likely to be successful in promoting PEB engagement among specific populations.

While many studies have examined gender differences in feedback response in the context of academic and workplace achievements, no research to our knowledge has examined whether men and women respond differently in terms of affect and causal attributions to feedback on their lifestyle choices, specifically PEB engagement. Research had identified that women are more likely to underestimate their abilities of some tasks and more likely to recall their mistakes relative to men (Beyer, 1998, 1999). Similarly, some studies have found that men

make more internal attributions for success, while women make more internal attributions for failure (Kivilu and Rogers, 2011). Additionally, a United States study found that women were more knowledgeable about climate change than men, yet interestingly, were more likely to underestimate their scientific knowledge of climate change (McCright and Dunlap, 2010).

Since studies on gender differences in feedback have not been extended to carbon footprint feedback, there is no way to know if the way individuals process an exam grade occurs similarly to the way they process their carbon footprint. There is evidence that women hold stronger environmental attitudes, demonstrate higher levels of awareness, and stronger responses to environmental problems, suggesting that current environmental communications strategies are reaching women more than men, but little research on why this difference exists (McCright and Dunlap, 2010). Since a psychological response to feedback is essential to an intervention's effectiveness, determining whether there is a gender difference in how males and females process feedback on their consumption can help identify why some interventions succeed while others fail. This study can pave the way for future research on how socialization and psychological processes influence the perception of carbon footprint feedback, which can shed light on how individuals are responding (or not responding) to environmental messages. Specifically in the context of this research, examining what message frames appeal to women versus men could inform eco-friendly product advertising, individually-tailored environmental feedback messages, and other interventions seeking to promote PEB in society.

Literature Review

Gender Differences in Environmental Knowledge, Attitudes, and Concern

When looking to previous literature surrounding gender and environmentalism, there is strong evidence of modest gender differences in environmental attitudes across culture and age, but these differences are not well understood. For example, in a study on school-age children across 14 different countries, girls displayed stronger value-based ecocentric environmental attitudes based on the New Ecological Paradigm (NEP) and greater participation in PEB relative to boys (Zelenzy, Chua, and Aldrich, 2000). In a comparative study of German and Russian adolescents on environmental awareness (combining factual environmental knowledge, affective and behavioral awareness, and values related to the environment), girls displayed stronger awareness than boys among both German and Russian adolescents, and environmental awareness and behavioral tendencies were highly correlated. (Szagun & Pavlov, 1995). In a study of 6,000 adolescents in Hong Kong, women scored significantly higher in environmental attitude, environmental concern, perceived seriousness of environmental problems, and perceived environmental responsibility (Lee, 2013).

Additionally, a 1983 examining the relationship between gender and environmental concern among a sample of the general public (N=806) and a sample of members of environmental organizations (N=407) found modest support that women are more

environmentally concerned than men, and these results persisted when controls for age, income, education and residence were introduced (Dunlap, 1983).

Studies on the perception of environmental risks also suggest that women hold stronger environmental attitudes and demonstrate higher levels of awareness and response to environmental problems (McCright and Dunlap, 2010). Researchers have found that women report higher perceived vulnerability to risks from climate change, hazardous wastes, and higher concern about the negative outcomes of environmental damage than men (O'Connor, Bord, & Fisher, 1997). In a study on attitudes about climate change, variability impacts, mitigation and adaptation strategies, female responses indicated they were 1.88 times more likely than men to take voluntary climate mitigation actions (i.e., Using public transportation, recycling, reducing home energy consumption) (Semenza et al., 2011). Additionally, a United States study found that statistically adjusting for other factors, such as political orientation, educational level, age, race, and income, women were more knowledgeable about climate change than men (McCright and Dunlap, 2010).

Potential Explanations for Gender Differences in Environmentalism

While there is significant evidence that women display higher levels of environmental concern than men, there has been little research examining the underlying reasons for these differences (Davidson and Fruedenberg, 1996). Various theories have arisen explaining a potential difference in environmental attitudes as a product of gender socialization, with findings inconsistent across studies. Studies have found that, compared to men, women have stronger altruistic tendencies (Dreber et al., 2014), hold stronger altruistic and biospheric values (Lee et al. 2013), a stronger ability to take the role of a conceptualized other (i.e., other orientation), (Gough 1960, 1994; Zelenzy et al. 2000), and stronger levels of social responsibility (Borden and Francis, 1978). A comparison of individuals with high and low environmental concern found high-environmentally concerned individuals had a stronger person orientation, and ethical-conscientiousness (Borden and Francis, 1978). Additional studies have shown that individuals consider pro-environmental behaviors to be prosocial and altruistic (Griskevicius, Tybur, & Van den Bergh, 2010) and that those with an interdependent, or extended-other orientation are more likely to make eco-friendly purchases, even if those items are more expensive (Chuang, Xie, Liu, 2016). In addition, consumers were found to purchase electric vehicles in order to create an identity demonstrating moral care and concern for others (Heffner et al., 2007) Other researchers have argued that because white men in particular have a privileged social status, they have a stronger psychological tendency to engage in 'system justification,' or motivation to justify the societal status quo, explaining why they have lower willingness to acknowledge environmental risks and mitigation strategies (Goldsmith, Feygina, & Jost, 2012).

More recently a series of seven studies suggested that the concepts of *greenness* and *femininity* were cognitively linked, and researchers identified the notion of a 'green-feminine stereotype,' suggesting gender-identity maintenance could influence the adoption of certain behaviors among men (Brough et al. 2017).

Translation of Environmental Attitudes, Risk Perceptions, and Concerns to PEB

While there is significant empirical evidence that women hold stronger environmental attitudes, risk perceptions, and concerns than men, whether these differences translate into differences in environmental behaviors and responses to feedback on these behaviors needs more exploring. While early rationalist models of PEB argued that increasing environmental knowledge increased environmental attitudes, and as a result environmental behavior in linear fashion, the knowledge deficit model has been proven incorrect numerous times (Kollmus and Agyeman, 2002). In fact, there is a major discrepancy between environmental attitudes and environmental behaviors--an inconsistency often called the 'environmental-attitude behavior gap.' (Kennedy, Beckley, McFarlane, & Nadeau, 2009; Kollmuss & Agyeman, 2002).
The discrepancy between environmental attitudes and environmental behaviors has been identified in many studies, including those analyzing gender differences in environmentalism. While a study on school-age children and across 14 different countries found that girls participated in more pro-environmental behaviors relative to boys (Zelenzy, Chua, and Aldrich, 2000), others found that while women display more environmental concern than men, they are no more likely to engage in environmental action (Blocker and Eckberg, 1997). However, a study on Australian young people found that female respondents reported engaging in more pro-environmental actions than males in two samples: 12-17 year olds (N=1529) and 18-24 year olds (N=2192) (Fielding and Head, 2011). A 2013 study found that women have higher green purchasing behavior than men in Hong Kong (Lee, 2013) while an additional study in China found that while women demonstrate greater participation in environmental behaviors inside of the home, no gendered patterns exist outside of the home (Xiao and Hong, 2018). Given the mixed findings regarding a gender difference in PEB, in addition to discrepancies on whether there is a relationship between environmental attitudes and behavior, future research is needed to clarify conflicting results. Perhaps the link between environmental attitudes and PEB is moderated by gender, and this warrants future research.

Gender Differences in Types of Pro-Environmental Behaviors

More specifically, looking at whether gender differences exist in the *type* of environmental behaviors engaged has not been researched extensively, and research on this topic can lead to more informed feedback intervention strategies.

In a cross-national study of gender variation across 22 countries, while women were found to engage in more pro-environmental behaviors than men overall, they were also found to

engage in more "private" or household pro-environmental behaviors (Hunter et al 2004). In addition, a 1992 study on environmental activism found that although women displayed more environmental concern than men, they were less likely than men to be members of environmental organizations (Mohai, 1992). A 2018 study on 2,057 nonprofit environmental organizations across the United States found that males occupied 62% of board positions, yet comprised less than half of staff (Taylor, 2018). This warrants future research on gender bias and socialization in the context of environmentalism.

Gender Differences in Diets and Food Purchasing Behaviors

Studies analyzing food consumption have found the energy consumption is 14-21% higher for men than women, due to differences in meat consumption (Carlsson-Kanyama et al. 2003) and the fact that vegetarianism is more prominent among women than men (Greene-Finestone et al. 2005; Raty, Carlsson-Kanyama 2009). A 2013 study found that male undergraduates used more direct, unapologetic strategies to justify eating meat (i.e. including endorsing pro-meat attitudes, denying animal suffering, believing that animals are lower in a hierarchy than humans and that it is human fate to eat animals) while women used more indirect justification strategies (i.e. avoided thinking about how the animal was treated, disassociated the animal from the food on their plate) (Rothgerber, 2013). A second study found that masculinity was positively correlated with beef consumption, chicken consumption, and pork consumption, and negatively correlated with the amount of vegetarian meals consumed (Rothgerber, 2013). Additionally, a content analysis of *Men's Health,* a lifestyle magazine for men, found that meat (red meat in particular) was significantly associated with positive elements of masculinity, and meat eating was identified as an attribute of an 'ideal man' (Stibbe, 2004). In addition, studies have found that women consider purchasing organic food more important (Van Doorn and Verhoef, 2011) and are more likely to include it in their purchases (Dettmann and Dimitri, 2007). Interestingly, a study on responses to a Single-Use-Carrier-Bag charge (SUCBC) found small gender effects with women actually reducing the frequency of bringing their own bags while grocery shopping over time (Thomas, Poortinga, and Sautkina, 2016).

Gender Differences in Transportation Behaviors

In terms of public environmental behaviors, research on transportation has shown that men use cars more than women (Hamilton and Jenkins, 2000) and travel more relative to women (Raty, Carlsson-Kanyama 2009). Like meat consumption's association with masculinity, researchers have identified the strong relationship between cars and constructions with masculine identities (Balkmar, 2012). In addition, a study on electric vehicle adoption intentions identified that being a woman was associated with lower willingness to pay, which could potentially be attributed to the gender-pay gap (White and Sintov, 2017).

Gender Differences in Energy Use

Looking specifically at household energy consumption, a study of Midwestern household energy use found that relative to men, women were more likely to engage in energy-saving practices and were more willing to pay a higher price for energy-efficient light sources (Lee et al. 2013). However, there were no gender differences present in the purchase of energy-efficient light sources and support of environmental policies banning inefficient light sources (Lee et al. 2013). More research needs to be done on whether demographic variables, such as gender, influence which environmental behaviors people do or do not engage in, particularly in the context of household energy consumption.

Introduction to Attribution Theory in the Context of Feedback Interventions

Given the need for increased PEB engagement, environmental psychologists are increasingly developing feedback intervention strategies (i.e. carbon footprint feedback, individual energy consumption reports) in order to influence individual future performances. Because a psychological response to feedback is necessary to elicit behavior change, examining the psychological processes following feedback interventions can inform environmental feedback intervention strategies. Attribution theory is important to discuss in the context of feedback intervention strategies because it plays an important role in how individuals process positive versus negative feedback (Weiner, 1985). External attributions relate the cause of events to something outside of oneself (i.e. test difficulty), while internal attributions relate the cause of events to something within oneself (i.e. intelligence level (Weiner, 1985). Additionally, stable attributions are consistent over time (i.e. ability) while unstable attributions are situational (i.e. poor effort, bad luck) (Weiner, 1985). According to Weiner's attribution theory, failure to meet goals elicits spontaneous causal activity in individuals, and the intensity and number of external causal attributions generated are greater after negative than positive actions in order to avoid unpleasant affective states (Bohner et al. 1988, Weiner, 1985). In the context of feedback strategies, studies have shown that the strength of feedback operates by inducing either positive or negative affect states (Fishbach et al., 2010), and that feedback that is both unexpected and elicits negative affect generates the most external causal attributions (Weiner, 1985). When people attribute events to external factors, they are more likely to discount feedback messages and not alter their subsequent behaviors—a phenomenon known as the Discounting Principle (Kelley, 1973). Additionally, meta-analyses have identified that internal attributions are related to PEB (Bamberg & Möser, 2007; Hines, Hungerford, & Tomera, 1987). Therefore, examining the attribution style of individuals following carbon-footprint feedback can measure feedback message effectiveness.

Gender Differences in Attributions and Feedback Response

While there is much research on psychological reactions to feedback interventions, whether these processes occur differently among men and women is a question that has been underexplored in the context of feedback on environmental behaviors. Research on whether individuals identifying with different genders respond differently to negative feedback overall is mostly inconclusive. However, there is some evidence that women make more stable, internal attributions (e.g., lack of ability) for failure, and external attributions for success than men, who tend to make internal attributions for success and temporary, external attributions for failures (e.g., poor effort, bad luck) (Nicholls, 1975, Dweck and Reppucci, 1973, Dweck, Goetz and Strauss, 1980).

A study on academic achievement attributions among students in Kenya identified that men made more internal attributions for success, while women made more internal attributions for failure (Kivilu and Rogers, 2011). An additional study in India found that successful females made greater attributions to luck, task difficulty, and stability relative to males (Misra and Misra,1986). In a study of young U.S. women's attributions to success and failure in nursing, teaching and medicine, women were more likely to explain success by attributing it to 'easier courses' than men, and women saw cheating as a less important cause of success when men succeeded relative to women (Feather and Simon, 1975). Other studies have supported the notion that men display higher *luck* attributions (external, unstable) after failure, and higher *ability* attributions after success (internal, stable) relative to women (Nicholls, 1975, Dweck and Reppucci, 1973, Dweck, Goetz and Strauss, 1980). In addition, researchers have also identified that women are more likely to underestimate their abilities of some tasks and more likely to recall their mistakes relative to men (Beyer, 1998, 1999) and are more likely to underestimate their knowledge of climate change (McCright and Dunlap, 2010). However, other studies have determined that no significant gender differences regarding causal attributions to feedback exist (Mezulis, Abramson, Hyde, & Hankin 2004).

In line with attribution theory, if women make more internal attributions for poor performance, then this would result in subsequent improved performances relative to men making external attributions for poor performances, which would elicit dismissal of the feedback according to the discounting principal (Weiner, 1985; Kelley, 1973). Yet, some theorists have found that women perform worse after receiving negative feedback relative to men, which warrants closer examination (Dweck and Reppucci, 1973).

Because there is inconclusive evidence on whether gender differences exist in relation causal attributions, specifically on environmental behaviors, analyzing potential gender differences in this area can demystify whether men and women have different attribution styles following carbon footprint feedback and inform environmental feedback strategy effectiveness. It is important to note that many of the above studies focused on feedback intervention in lab settings, public social situations, and education and testing contexts, in contrast to feedback on household energy consumption and personal environmental behaviors. In other words, it is unclear whether the attributional processing of an exam grade occurs similarly to the attributional processing of carbon footprint feedback. Due to the established gendered

component of environmental attitudes, but lack of consensus on determinants of these values and whether these attitudes translate to behaviors, analyzing causal attributions to feedback on environmental behaviors can shed light on the psychological processes preceding pro-environmental behavior change. In summary, this study addresses lack of consensus on whether a modest gender difference in environmental attitudes will translate to gender differences in type and quantity of PEB, and addresses whether gender differences in changes in PEB following feedback intervention can potentially be explained by differences in subsequent affect and causal attributions.

Research Questions

1. Are there gender differences in environmental attitudes?

2. Are there gender differences in environmentalist identities?

3. Are there gender differences in the type and quantity of PEB engaged in at the baseline level (overall participation in PEB and the frequency of any specific PEBs)?

4. Are there gender differences in the type and quantity of PEBs engaged in following feedback interventions (overall participation in PEB and the frequency of any specific PEBs)?

5. Are there gender differences in subsequent causal attributions and affect following feedback on PEB?

Hypotheses

Based on review of literature, the following hypotheses were made:

H1: Females overall will have higher NEP and environmentalist identity scores relative to males.

H2: Females will engage in more overall baseline PEB than males, and the main gender differences between pro-environmental choices will occur in diet, with females making more pro-environmental choices relative to males in this area.

H3: Females will display stronger PEB following negative feedback intervention, and stronger changes in PEB following negative feedback intervention, with no changes in gender differences in the types of PEBs engage in.

H4: Females will display stronger levels of negative affect and display higher internal attributions following negative feedback relative to males.

Methods

Participants

This study was part of a larger project that investigated relationships between causal attributions and self-conscious emotions in pro-environmental decision-making. The present study utilized a sample of 393 U.S. adults collected using the survey platform Prolific Academic. The demographics of the sample were as follows: 237 males, 156 females (~60% men, ~40% women). Only 4 participants selected an option other than 'male' or 'female.' This study was limited by sample size, so could not assess diverse gender expressions due to statistical validity. Future research should examine data sets that encapsulate all gender expressions. The average age of the sample was 33.05, and the sample was 77.4% white, 60.3% liberal, 21.9% moderate, and 17.8% conservative.

Procedures

Participants' baseline PEBs were measured using an adapted version of the Recurring Pro-Environmental Behavior Scale (Brick et al., 2017). Participants then answered questions from the CoolClimate Carbon Footprint Calculator (The Berkeley Institute of the Environment, 2008) before receiving the feedback message. In order to increase believability of the affective valence of the feedback message, answer choices were adapted—skewed lower for negative feedback conditions and higher for positive. Next, participants were randomly assigned to receive a *bogus* feedback message on their carbon footprint, supposedly based on their responses regarding their behaviors. In all feedback conditions, participants were told their carbon dioxide footprint was 17 metric tons per year.

Additional text in feedback messages was manipulated to be framed as positive, negative, or neutral, and were written as follows:

Negative: *Your estimated carbon dioxide footprint is 17 metric tons/year. This is bad! It is terrible that you are not doing all that you can to help the environment. Your footprint results suggest that you do not care, do not conserve energy, are not careful about waste, and do not take actions to help your community become a sustainable place to live. Your results are poor.*

Neutral: *Your estimated carbon dioxide footprint is 17 metric tons/year. This is neither good nor bad. It is worth knowing that your behavior can impact the environment. Your footprint results suggest that your behavior can either raise or lower your carbon dioxide footprint. Your results are adequate.*

Positive: *Your estimated carbon dioxide footprint is 17 metric tons/year. This is good! It is wonderful that you are doing what you can to help the environment. Your footprint results suggest that you care, conserve energy, are careful about waste, and take actions to help your community become a sustainable place to live. Your results are excellent.*

Measures

Environmental Attitudes: Environmental attitudes were assessed using the Revised New Environmental Paradigm (NEP) scale adapted from Dunlap, Van Liere, Mertig, and Jones (2000) which contains fifteen items (e.g. Nature is a limited resource upon which humans rely) that are answered using a 5-point likert scale (1=strongly agree, 5=strongly disagree) using a Likert scale (Cronbach's $\alpha = 0.88$).

Environmentalist Identity: Environmentalist identity was assessed with three items answered on a seven-point likert scale (1=strongly disagree, 7=strongly agree) adapted from van der Werff, Steg, and Keizer (2013). These items were: Acting environmentally friendly is an important part of who I am; I am the type of person who acts environmentally friendly; I see myself as an environmentally friendly person (Cronbach's $\alpha = 0.91$).

Causal Attribtions: Causal attributions for the feedback were measured using an adapted version of the Revised Causal Dimension Scale (McAuley, Duncan, & Russell, 1992). The scale measures the causal dimensions of locus of causality, stability, and controllability (both personal and external) using 12 items, and items are each rated on biplar nine-point scales (e.g.,"insert question stem" 1 = inside of you/9 = outside of you). For this analysis, we wanted to look specifically at attribution (internal vs. external) dimension items. Two of the predicted locus of causality (i.e., all predicted locus of causality items except "Inside of you / Outside of you") and all three predicted personal control items loaded together onto a single factor, which we label as "internal attribution." The the mean of each of five items was taken to form a LocusPlus score for each participant. Items were reverse scored in which higher values indicated higher internal attributions of the cause of feedback messages (Cronbach's $\alpha = 0.71$).

Baseline and Follow-up PEB: Baseline PEB was measured using an adapted version of the Recurring Pro-Environmental Behavior Scale, which measures 16 PEBs (e.g. recycling, conserving water, turning off lights) using a five-point unipolar frequency scale (1=Never, 5=Very Often). The mean of each PEB was taken to form an overall baseline PEB score for each participant (Brick et al., 2017) (Cronbach's $\alpha = 0.74$). One week after receiving the feedback, Follow-Up PEB (behaviors engaged in over the past week) was assessed using the same methodology (Brick et al., 2017) (Cronbach's $\alpha = 0.78$).

The list of PEBs self-reported were as follows:

- *Use reusable bags when you visit the grocery store*
- *Walk, bicycle, carpool, or take public transportation instead of driving*
- *Open windows/use fans instead of adjusting AC*
- *Put on extra layers of clothes/blankets instead of adjusting heat*
- *Compost your household food scraps*
- *Eat meat (reverse scored)*
- *Eat dairy products (reverse scored)*
- *Eat organic food*
- *Eat local food*
- *Turn your personal electronics off or in low-power mode when not in use*
- *Turn off the lights when you leave a room*
- *Act to conserve water when showering, cleaning clothes etc.*
- *Recycle*
- *Discuss environmental topics*
- *Carry a reusable water bottle*
- *Engage in environmental political action or activism*

Results

H1: Females overall will have higher NEP and environmentalist identity scores relative to males.

Independent samples t-tests examining the effect of gender on NEP environmental attitudes revealed that there were no significant gender differences in NEP environmental attitudes [F (1,391)=, p=.257]. Independent samples t-tests examining the effect of gender on environmentalist identities revealed that there were no significant gender differences in environmentalist identities [F (1,391)=.021, p=.866]. H1 was not supported.

H2: Females will engage in more overall baseline PEB than males, and the main gender differences between pro-environmental choices will occur in diet, with females making more pro-environmental choices relative to males in this area.

A one-way ANOVA examining the effect of gender on baseline PEB revealed a significant effect of gender on baseline PEB [F (1,391)=8.705, p=.003]. Females engaged in significantly more baseline PEB overall and among several specific behaviors relative to males (see table X). H2 was partially supported. Females engaged in more overall baseline PEB than males, but this difference was not attributed to diet alone.

Table 1A: Significant Effect of Gender on Baseline PEB Engagement:

There was a significant gender difference in baseline PEB engagement in the following behaviors:

Baseline PEB	**Male Mean (SD)**	**Female Mean (SD)**
Overall	2.73** (.546)	2.92**(.583)
Eating less meat	1.95*** (.992)	2.43***(1.18)
Using reusable bags	2.59** (1.53)	3.08**(1.58)
Using reusable bottles	3.19** (1.50)	3.71** (1.43)
Conserving water	2.88* (.837)	3.16* (.749)

(*p<.05, **p<.01, ***p<.0001)

Table 1B: No Significant Effect of Gender on Baseline PEB Engagement:

There was no significant gender difference in baseline PEB engagement in the following behaviors:

Baseline PEB	**Male Mean (SD)**	**Female Mean (SD)**
Walk, bicycle, carpool, or take public transportation instead of driving	2.54 (1.47)	2.54 (1.56)
Open windows/use fans instead of adjusting AC	3.13 (1.33)	3.30 (1.41)
Put on extra layers of clothes/blankets instead of adjusting heat	2.95 (1.52)	3.12 (1.54)
Compost your household food scraps	1.68 (1.21)	1.90 (1.37)
Eat dairy products (reverse scored)	2.28 (1.12)	2.09 (1.09)
Eat local food	3.15 (1.03)	3.01 (1.06)
Eat organic food	2.58 (1.13)	2.52 (1.11)

Turn your personal electronics off or in low-power mode when not in use	3.26 (1.27)	3.28 (1.33)
Turn off the lights when you leave a room	4.41 (.837)	4.51 (.749)
Recycle	3.67 (1.32)	3.72 (1.40)
Carry a reusable water bottle	3.19 (1.50)	3.71 (1.43)
Discuss environmental topics	2.16 (1.14)	2.28 (1.13)
Engage in environmental political action or activism	1.70 (.961)	1.81 (1.02)

H3: Females will display stronger PEB following negative feedback intervention, and stronger changes in PEB following negative feedback intervention, with no changes in gender differences in the types of PEBs engage in.

A one-way ANOVA examining the effect of gender on follow-up PEB revealed a significant effect of gender on follow-up PEB [$F(1,391)=9.406$, $p=.003$]. Partially supporting H3, females engaged in significantly more overall PEB at follow-up and among specific behaviors relative to men.

Table 2A: Significant Effect of Gender on Follow-Up PEB Engagement:

There was a significant gender difference in post-feedback PEB engagement in the following behaviors:

Post-Feedback PEB level	**Male Mean (SD)**	**Female Mean (SD)**
Overall	2.79** (.605)	2.98** (.584)
Eating less meat	2.20*** (1.06)	2.69*** (1.19)
Using reusable bags	3.2*** (1.46)	3.76*** (1.37)
Using reusable bottles	3.57*** (1.41)	4.14*** (1.19)
Adjust AC less	3.39* (1.28)	3.67* (1.29)

Adjust heat less	3.35* (1.35)	3.65* (1.35)
Compost	2.04* (1.36)	2.33* (1.45)
Turn off lights	4.52* (.795)	4.70* (.584)

(*p<.05, **p<.01, ***p<.0001)

Table 2B: No Significant Effect of Gender on Follow-Up PEB Engagement:

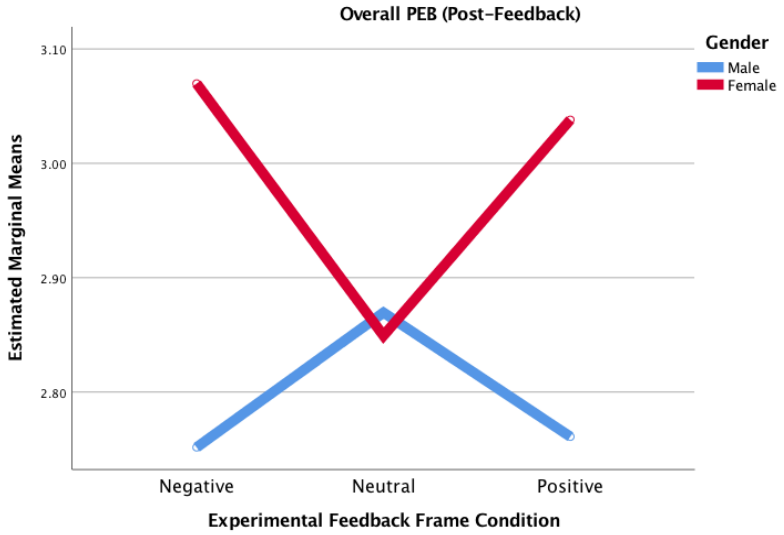
There was no significant gender difference in post-feedback PEB engagement in the following behaviors:

Post-Feedback PEB level	**Male Mean (SD)**	**Female Mean (SD)**
Walk, bicycle, carpool, or take public transportation instead of driving	2.59 (1.44)	2.65 (1.59)
Eat dairy products (reverse scored)	2.28 (1.05)	2.49 (1.11)
Eat organic food	2.51 (1.16)	2.51 (1.09)
Eat local food	3.00 (1.08)	2.93 (1.07)
Turn your personal electronics off or in low-power mode when not in use	3.37 (1.15)	3.50 (1.19)
Act to conserve water, when showering, cleaning clothes etc.	3.21 (1.20)	3.46 (1.15)
Recycle	3.68 (1.33)	3.85 (1.36)
Carry a reusable water bottle	2.13 (1.17)	2.24 (1.13)
Discuss environmental topics	3.22 (1.51)	3.77 (1.41)
Engage in environmental political action or activism	.961 (1.62)	.932 (1.67)

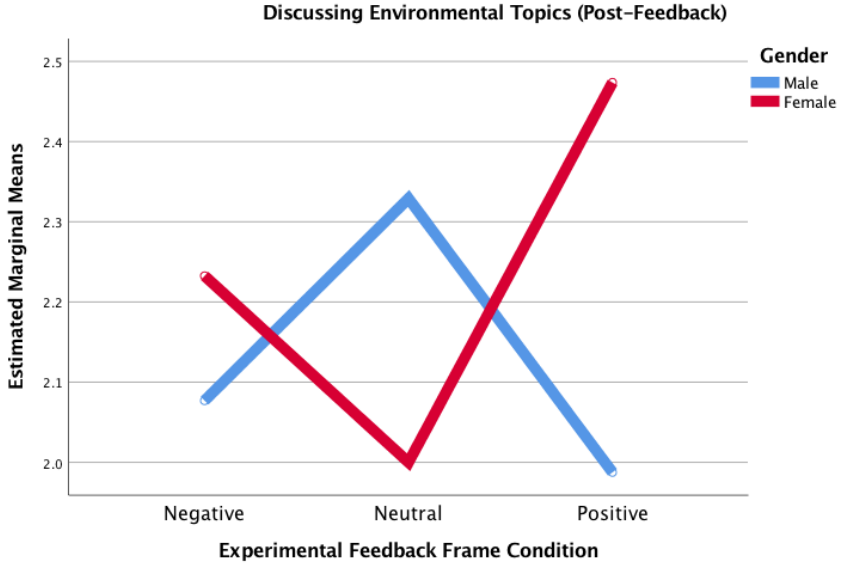
A series of two-way ANOVAs testing the effect of feedback frame on post-feedback PEBs by gender was conducted and revealed a significant interaction between gender and feedback frame

on: overall post-feedback PEB (p=.049), discussing environmental topics (p=.016), using reusable bags (p=.008), and engaging in political action/activism (p=.004).

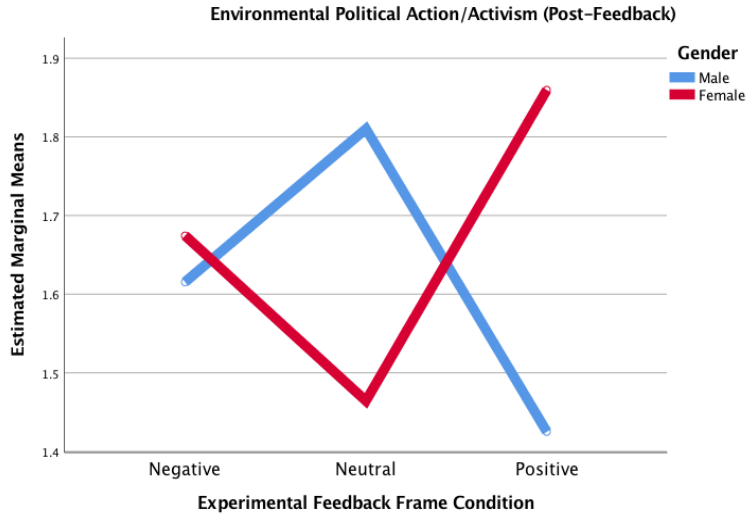
For overall post-feedback PEB, females scored higher than males in the positive and negative feedback condition, while males scored highest in the neutral condition.



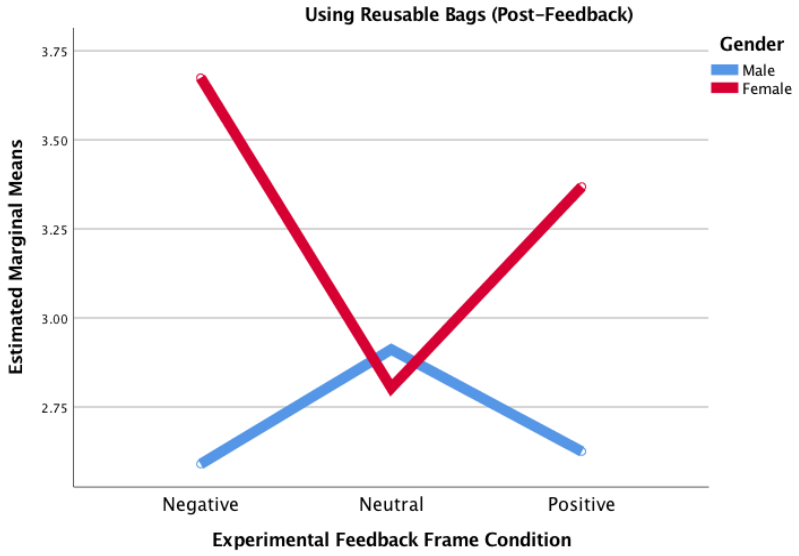
For discussing environmental topics post-feedback, females scored higher than males in the positive and negative feedback condition, while males scored highest in the neutral condition.



For engaging in political action post-feedback, females scored higher than males in the positive and negative feedback condition, while males scored highest in the neutral condition.



For using reusable bags post-feedback, females scored higher than males in the positive and negative feedback condition, while males scored highest in the neutral condition.



H4: Females will display stronger levels of negative affect and display higher internal attributions following negative feedback relative to males.

H4 was not supported. In a two-way ANOVA examining the effect of feedback frame on post-feedback negative affect across gender, there was a significant main effect of feedback frame, whereas those who received negative feedback had higher negative affect than those who received positive or neutral feedback [F (2,387)= 34.15, p=.00). There was no main effect of gender [F (1,387)=.041, p=.839] and the interaction between gender and feedback frame was not significant [F (2, 387)= 1.31, p=.272].

In a two-way ANOVA examining the effect of feedback frame on subsequent attributions across gender, there was a significant main effect of feedback frame, whereby those who received negative feedback made more external attributions than those who received positive or neutral feedback [F (2,387)= 17.07, p=.00). There was no main effect of gender [F (1,387)= 2.29, p=0.13] and the interaction between gender and feedback frame was not significant [F (2, 387)= 0.511, p=.60].

Discussion

While previous research has found that females have stronger environmental attitudes and identities than males, but that the translation from attitudes to behavior is less clear, these findings reveal that females are engaging in higher levels of PEB than males. This study found that overall, females engage in more PEBs relative to males at baseline and after receiving feedback. This difference was driven by specific PEBs (i.e., eating less meat, using reusable bags/bottles, adjusting AC/heat less, conserving water, composting, turning off lights). Additionally, we found that males and females differentially responded to feedback framed in different ways. Overall, females who received positive (and for some behaviors, negative) feedback reported engaging in the most follow-up PEB. Furthermore, females reported engaging in more PEB following positive feedback, particularly for behaviors that involve social interaction. This study highlights that it is important to distinguish between different types of PEBs when measuring environmental behavior. Treating PEB as a homogenous construct decreases the ability to detect important (i.e., gender) differences in PEB engagement, and intervention effectiveness.

This research also sheds light on how gender moderates feedback response. Some researchers have found that females perceive all evaluative feedback, and particularly negative feedback, to be more informative about their abilities than do males, while males' self-assessments are less influenced by feedback overall (Roberts, & Nolen-Hoeksema, 1989). Supporting previous research, we found females were influenced more by positive and negative feedback than males, but the influence actually occurred in the level of PEB engagement—not in self-assessments (i.e. affect or attributions) following feedback. Contradicting previous research, we found no gender differences in attributions following feedback, raising questions on what psychological factors explained the gender gap in PEB engagement that future research should examine. These findings support previous research that found feedback improved female performance more compared to their male counterparts (Djamasbi & Loiacono, 2002), and contradicts previous research arguing that females perform worse relative to males after receiving negative feedback (Dweck & Repucci, 1973). We found that in some cases (i.e. using reusable bags) the opposite effect was true, with women reporting engaging in the most PEB after receiving negative feedback. While the social desirability bias could play a role here, it seems unlikely given the context—an anonymous, online survey.

Additionally, given that there were not gender differences in all specific behaviors, it is worth examining what stands out about the particular PEBs in which a gender difference was significant. The specific PEBs came from different 'categories' (i.e. transportation, diet, energy usage) and there was no apparent pattern here. However, when looking at the interactions between gender and feedback conditions, the results suggest that positive feedback on PEB encourages women (but not men) to participate in more visible and public environmental actions involving high levels of social interaction (i.e. discussing environmental topics and engaging in environmental political action/activism).This suggests that perhaps female pro-social orientation makes women feel connected to environmental 'others' when they receive positive feedback on their consumption. Additionally, some researchers have argued that women's pro-social orientation explains that women are more influenced by positive and negative feedback because of they desire and are socialized to maintain relationships (Carlson, 1972). Perhaps women are socialized to have more inclination to fulfill normative goals of liking and acceptance, which is more likely when actions are visible to others. Similarily, a study on energy consumption feedback found that pro-social orientation was found to interact with goal-setting mode, with pro-self individuals saving more energy when allowed to self-set a goal and pro-social individuals saving more energy when assigned a goal (McCalley & Midden, 2002). If women are more pro-social than men, perhaps they respond better to feedback that advises behavior change, as in the positive and negative conditions, while men respond better to feedback that simply reports their carbon foorprint results, and allows them to self-assign a behavior change (or not). This could explain why women responded better to emotionally-valenced feedback, in addition to why they reported in engaging in more PEB overall following feedback. More research is needed to determine whether this phenomenon exists in other pro-social behaviors, in addition to PEBs.

The notion that women react positively to encouragement regarding PEB, while this encouragement has the opposite effect on men, raises questions regarding the concept of the green-femininity cognitive link, suggesting that perhaps men shy away from being perceived as environmentally friendly because they associate environmentally friendly as feminine. Studies on meat eating's relationship with constructions of masculinity, 'green consumption' and vegetarianism's association with femininity can shed light on this subject (Brough et al., 2016, Rothgerber, 2013). Furthermore, some theorists have argued that men are more likely to avoid altering their behaviors on the basis of system justification and higher motivation to justify the societal status quo, explaining why they respond negatively to valenced messages encouraging environmental behavior change (Goldsmith, Feygina, & Jost, 2012). Interestingly, we found no gender differences in environmentalist identities or environmental attitudes. Overall, this research sheds light on engagement in 16 PEBs, and suggests that there is a gender gap in PEB engagement, with women participating more than men. These findings support the need for future research investigating how gender socialization influences individual's willingness to engage in PEB and response to feedback on PEB. Finally, our research supports previous

research that men and women respond differently to evaluative feedback, and suggests that these differences translate to behavioral differences as well.

Analyzing gender differences in changes in pro-environmental behaviors following feedback intervention is necessary to evaluate if certain groups respond stronger to certain types of feedback. If people that identify with a certain gender are more likely to have a certain environmental attitude or engage in a certain environmental behavior, this information can be applied to create more strategic messaging targeting specific demographics. In addition, if responses to feedback interventions on environmental behaviors vary based on gender, this too can inform more effective intervention strategies tailored to certain audiences. Knowing that females are engaging more in PEB relative to males, environmental psychologists must determine how to increase male engagement in PEB, and continue to support female efforts. Additionally, these findings reveal the need for further research investigating how gender socialization influences individuals' willingness to engage in PEBs. In terms of interventions, these findings suggest that feedback may be more effective in encouraging PEB if intervention strategists use more emotionally valenced language when targeting females, and neutral language when targeting males. Females were also found to engage in more visible, social, public behaviors after receiving positive feedback, suggesting that females, but not males, respond well to encouragement to behave more sustainably. More research is necessary to determine what factors contribute to male and female's different baseline engagement in PEB, and responses to carbon footprint feedback in today's society.

Limitations and Future Directions

A major limitation of this study is that the sample is younger, less racially diverse, and more liberal than the U.S. population. Another potential concern is that the baseline and follow-up PEB reports are self-reported, and therefore may not be a true reflection of behavior. Social desirability bias could undermine the validity of pre and post-feedback PEB in our study. Furthermore, people whose gender identity falls outside the male/female binary are not represented in our analyses. This analysis makes use of previously collected data, of which only 4 participants held a gender identity other than 'male' or 'female' and could not be included in our analyses due to statistical validity concerns. Future research on gender identities should collect larger samples that fully encapsulate the diversity of gender expression.' Understanding gender as a social construction, it is important to recognize that gender binaries have been historically entrenched in institutions, policies, and academic research, and that non-binary gender identities have historically been excluded from social science research in particular (Mertens, Fraser, and Heimlich, 2008). Increased inclusivity surrounding gender-focused research is sorely needed to reflect the diversity represented within populations.

Future research on the relationship between gender and PEB should recruit a larger more diverse sample that better reflects the U.S. population, and investigate why females appear to

engage in higher levels of PEB and respond stronger to positive and negative feedback on PEB relative to men. Additionally, while this research reveals gender differences in PEB engagement and response to carbon footprint feedback, it failed to capture the underlying psychological and sociological determinants contributing to these differences. Future research should seek to examine this.

Acknowledgements

My sincere thanks to Dr. Nicole Sintov and Ian Adams for their support, encouragement, and discussion. I would also like to thank the Environmental Behavior Change Research group for their valuable feedback. This work is supported by funding from the Decision Sciences Collaborative and a Sustainable and Resilient Economy Seed Grant.

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